

STUDIES ON THE PHYSICAL PROPERTIES
OF INSECT BAIT MATERIALS

by

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INTRODUCTION

For many years wheat bran was the chief carrier used in grasshopper baits. The drought conditions of the past few years caused a decrease in crops and an increase in the number of grasshoppers. Much of the land formerly planted with corn, was planted to wheat. The drought decreased the yields of the wheat and since it was replacing corn as a stock food, it became scarce. As a result the cost of this bran became too high to permit the farmer to buy it as a carrier and use it in poison bait to combat grasshoppers.

To provide other carriers and attractants, the state and federal governments aided by carrying out research work. The federal government also assisted by appropriating funds for fighting the grasshoppers. This increase in experimental work introduced many substitutes for bran. At the same time, attractants such as black strap molasses, salt, beet syrup, amyl acetate, and many others were added to the baits in an attempt to increase their efficiency.

The problem of fighting grasshoppers is facilitated by knowledge of the biological phase dealing with the life

histories and behavior, the ecological phase treating of the insects' environment, and of the physical properties and mechanics of the baits.

In the present study the moisture absorption and retention properties of ten carriers and several attractant solutions which are often used in grasshopper baits were investigated.

REVIEW OF LITERATURE

The poisoning of grasshoppers by the use of baits has been in operation for many years. Two of the older bait carriers used were horse droppings (21) and mash (15). Headlee published the formula for the Kansas mixture in 1912 (19). Bran proved to be the best carrier available in Kansas at that time. There were many materials used then as there are now. Wood (21) quoted Criddle as using sawdust with encouraging results in 1911-1913. Morrill (14) reported that pine sawdust and bran mixed in a 50/50 ratio gave practically the same results as the straight bran bait. Webster (20) tested alfalfa meal and sugar beet pulp as early as 1915. These are but a few of the many older reports concerning carriers and baits for fighting grasshoppers.

In recent years, the research on the bait carriers has been nearly a repetition of the early work. The tests not only considered the substitutes that were used in the place of bran, but the addition of attractants. Mitchener (11) reported that the addition of bran to sawdust baits improved the physical properties of the mixture. It broke up more readily when being scattered, and of course, had the other advantage of making a cheaper mixture. Later he used chopped green foliage as a bait and in 1933 said that malt sprouts proved to be an effective substitute for bran (12). Blunt (3) used coffee parchment, a waste product from coffee cleaning mills. Larrimer (8) reported that soap was distinctly attractive and that the addition improved the mechanical condition of the poison bait. In other tests Swenk and Wehr (18) found that fresh leaves were preferred to bran but were impracticable for use. They also noted that the attractiveness of the bait was not affected by the addition of molasses or soap and was only slightly increased for the adult grasshoppers by the addition of salt. Berezhkov (1) reported that salt applied in small quantities had no effect on maintaining the moisture of the bait, while, in large quantities it reduced the attractiveness. This quality in baits, he stated, depends mainly upon its

moisture and not upon aromatic substances (2). Cowan (5) concluded from tests in Colorado that there was no practical substitute for bran.

The reports by Paoli (17) and Mitchner (13) were the only published works which dealt with the absorption properties of the carriers. Paoli (17) in 1919 soaked several carriers in water and found that crushed grain absorbed 30 per cent of its weight of liquid, bran 70 to 90 per cent, ground maize cobs 125 per cent, slices of dried beet up to 300 per cent, white sawdust nearly 100 per cent, brown sawdust 70 per cent, and crushed olive stones 35 per cent. In this report there was no mention of the method in obtaining the above data. Paoli said that to be sure that the bait contained 4 per cent of its dry weight of sodium arsenite, the solution had to contain varying strengths of the poison, approximately 13 per cent of grain, 5 per cent for bran, 3.2 per cent for the cobs, 1.3 for beets, 4 per cent for white sawdust, 5 per cent for brown sawdust and 11.4 for crushed olive stones. The fact that the carriers require varying amounts of poison may be a partial explanation of the contrasting results obtained from the grasshopper baits.

Mitchner (13) ran similar experiments on the water absorbing abilities of the various carriers. He treated the carriers in the following manner:

Each of the carriers . . . was thoroughly wet with water. Some of each wet carrier was placed in duplicate moisture boxes and then placed in a moisture equivalent centrifuge which was run up to 370 revolutions in the seventh minute of operation. This centrifuging removed the excess water from each sample and left each with approximately the same quantity of water that would be present in a bait properly prepared for broadcasting. The amount of wet carrier was determined for each sample. Each carrier was then dried out in the vacuum oven as before.

He found the water absorbing ability of the carriers to be as follows: Young green wheat plants absorbed 95.2 per cent of water, malt sprouts 81.7 per cent, beet pulp 77.6 per cent, dry oat straw (approximately 1/2 inch) 76.0 per cent, dry wheat straw (approximately 1/2 inch) 69.8 per cent, bran 69.3 per cent, sawdust 67.9 per cent, and brewer's grains 62.6 per cent. He also conducted tests exposing dry baits for 55 hours out of doors to ascertain if they would absorb atmospheric moisture, but found that very little moisture was absorbed in this manner. His results showed that beet pulp increased in weight 1.3 per cent, sawdust 1.2, malt sprouts 1.1, brewer's grains 1.0, bran 1.0, oat straw 0.8 and wheat straw 0.4 per cent. Young wheat plants failed to increase in weight. As evident from these

results, the moisture absorbing properties of baits may be significant evidence of the low efficiency of some baits.

MATERIALS AND METHODS

In the present investigation, a few of the carriers and attrahents commonly used in the Great Plains area were tested. The carriers were wheat bran and shorts, corn cobs and stalks, alfalfa stem meal, beet pulp and several sawdusts. The attrahents were black strap molasses, beet syrup, glycerine and salt.

Wheat bran was obtained from the Department of Milling Industry at the Kansas State College of Agriculture and Applied Science. In accordance with the requirements of the State of Kansas, wheat bran has been described as "the coarse outer covering of the wheat kernel as separated from cleaned and scoured wheat in the usual process of commercial milling" (7). This covering is richer in protein and minerals and also much higher in fiber than the entire grain (16, p. 341). It usually contains about 10 per cent crude fiber. Wheat, like other plant substances, varies in the percentage of protein, crude fiber and other ingredients depending upon the variety of the wheat and where it was grown. When the wheat kernel is milled, the bran, germ,

and flour are separated. The germ is usually included with the bran. The flour is a mixture of carbohydrates and gluten. The gluten gives the wheat dough its tenacity (16, p. 341). In screening, some of the flour is lost and included with the coarser particles which comprise most of the crude fiber. When a large percentage of the flour is included with the fiber, it is known as wheat shorts. The wheat shorts which vary are sold under trade names of Red Dog, Wheat Red Shorts, Wheat Gray Shorts. They contain not over 4.0, 7.5, and 6.0 per cent of fiber, respectively. These shorts cannot be used alone as a carrier because the gluten they contain will cause it to form a gummy mass. At times wheat shorts are incorrectly called mill-run bran. The requirements state, "such terms as 'mill-run bran' and 'mill-run shorts' cannot be used to refer to a mixture of wheat bran and wheat shorts" (6).

The corn stalks were obtained from the college farm northwest of Manhattan. After the kernels were removed from the cobs, the latter were dried for several weeks. The cobs and stalks were ground separately in a hammer mill having a $3/8$ inch screen. A combination cutter, either a hammer mill or silage cutter, that can be set to cut the corn cobs and stalks into fine pieces, will chop up these

by-products. The cost of operation of cutting these as carriers should be much less than that of an equal bulk of bran. Inspection showed that the stalks contain a much larger percentage of pith than the ground cobs. As seen in Table 1 the stalks and cobs, with the exception of cottonwood sawdust, were the most bulky of all the materials.

The alfalfa stem meal used contained small pieces of stems and leaves which were ground so that they would pass through a 1/4 inch screen. The beet pulp was obtained from the Garden City Company, Garden City, Kansas, and was the same as that commonly sold for stock feed. This pulp was the fibrous part of the beet root which remained after it had been cut up, the sugar contents removed and it had been thoroughly dried. In this condition it closely resembled small pieces of alfalfa seed pods cut into lengths of 3/16 inch or less. After the beet pulp had absorbed some moisture, it had the appearance of match sticks broken up into short lengths. These broke apart readily when broadcasted.

The sawdusts, with the exception of kiln-dried, were of green timber. The kiln-dried sawdust was of seasoned lumber and contained less than 7 per cent moisture. Pine and cottonwood sawdusts were the only two which gained noticeably in bulk.

Table 1 shows the locality from which the carriers were obtained and the size of each carrier with the per cent of the bait in the different sizes. The data in Table 1 were determined by shaking a pint jar of representative material through calibrated sieving screens.

Table 1. The location and percentage of the dried carriers according to size of particles.

Materials	:	Location	:	Under	Under	Under
				6.35 mm:	2.0 mm:	0.84 mm
				Over	Over	:
				2.0 mm:	0.84mm:	
Cottonwood		Keokuk, Iowa		61.6	32.6	5.8
Kiln dried		Springfield, Mo.		14.6	37.8	47.6
Oak		Faulkner, Ks.		5.1	51.5	43.4
Pine		Effis, Minn.		24.9	50.8	24.3
Walnut		Hannibal, Mo.		13.1	67.4	19.5
Alfalfa stem meal		Garden City, Ks.		3.8	29.1	67.1
Beet pulp		Garden City, Ks.		9.9	66.6	23.9
Corn cobs		Manhattan, Ks.		47.9	35.2	16.9
Corn stalks		Manhattan, Ks.		43.3	32.4	24.3
Wheat bran		Manhattan, Ks.		6.2	62.1	31.7
Wheat shorts		Manhattan, Ks.		4.6	33.2	62.2

Mixtures of pine and kiln dried sawdust with wheat shorts were used in a 3/1 ratio. These combinations were compared to the straight carriers. By this means, the differences in the materials involved, whether a carrier or attrahent solution, were readily determined.

To eliminate all the moisture possible so that the absorption qualities of the carriers would be comparable, they were air-dried. Each carrier was spread out on a heavy piece of wrapping paper, which was laid on a flat topped radiator. The carrier remained there several days before it was stored in air-tight jars. Although the radiator was partially turned on, it was thought that the carriers did not, at any time, become hot enough to change their composition or their characteristics.

In addition to the carriers, many kinds of attrahents were employed to increase the efficiency of the poison baits. These varied according to the locality in which they were used. The beet syrup was obtained from the Garden City Company. It is sold as the necessary attrahent for grasshopper bait in that area. The molasses was obtained from the Department of Dairy Husbandry, Kansas State College, and was the same as that used in stock feed. It is commonly called "crude black strap molasses." The salt,

the same as that sold for human consumption, was purchased in a grocery store. The chemically pure glycerine was obtained from the Department of Chemistry of Kansas State College.

The attrahents were added according to the recommendation for field use. The recommendation for molasses was two gallons to 10 gallons of water, or 630 cc. to the gallon (9). Also diluted to this quantity were the beet syrup and glycerine mixtures. When reduced to a gallon basis, the field formula for salt which calls for four pounds to 10 gallons of water was 157 gm. (4).

Absorption

The absorption tests were carried on in the entomology greenhouse. A beam balance, two dozen pint jars with rubbers and lids, two screened-top jar lids and the air-tight gallon jars in which the bait materials were kept was the equipment used in these tests. The beam balance was of the ordinary laboratory type that will weigh accurately from 1/10 to 600 gm. The screened-top lids were made from ordinary jar lids which had the tops cut out and a fine mesh screening soldered in.

After weighing the pint jars they were labeled with their respective weights. The five representative samples

of bait carrier of 25 gms. each were weighed and placed in five pint jars. A sample was covered with water. After it had set for two minutes, the excess water was forced through the screened-top jar cover by shaking. The screened cover was then removed and the sample weighed. The weight of the jar, the 25 gm. sample and the water the sample had absorbed made up the sum of the reading obtained. From this reading the weight of the jar and of the original sample was subtracted, leaving the weight of the absorbed water.

The above treatment was repeated for each of the five samples. By adding the totals and dividing by five, the mean weight of the moisture retained by the bran was obtained. The percentage absorbed by the carrier was determined by dividing the weight of the original sample, 25 gms., into the mean.

This procedure was repeated, but this time the water was allowed to set over the bran for eight minutes, making a total of ten minutes soaking. Similarly each sample was soaked for 30, 60, 90, 240, and 720 minute intervals and the percentage of moisture obtained.

When this had been accomplished for each carrier, an attractant solution was substituted for the water and applied to the various carriers and mixtures. Later, the

same tests were run for the other attractants. This gave comparable tests of the attractants, the materials and the mixtures of materials.

Possible sources of errors in the above technique are as follows: The mesh screening on the jar tops was fine but the shaking action caused very fine particles of the bran and other materials to be lost. The amount lost was so small as compared to the size of the sample, 25 gms., and the variation in the total amount of moisture driven out by shaking, that the loss was not thought sufficient to affect the results significantly. After the sample was soaked for a short interval and the water driven off, there was a short period during weighing that the sample had no water covering it. Since the sample was wet on the outside only and the moisture continually penetrated to the sample, the end result would not be the same as if new samples had been employed for each interval soaked. Since the materials were treated the same, the results are comparable.

Evaporation

In the evaporation tests the equipment used was a chainometric analytical precision balance, a hygrothermograph, a Buchner funnel setup, and a roll of waxed paper. The chainometric balance would weigh from 1/1000 to 200

grams accurately. It is the balance generally used in a research chemistry laboratory. The hygrothermograph recorded the temperature and the relative humidity of the room where the experiments were run. The Buchner funnel was used to drain the liquids from the different samples. It created a suction which drew the liquid away from the materials in the funnel through a filter paper. The waxed paper had a waxen finish on both sides and was cut into pieces of six by eight inches. Each piece was numbered and weighed.

The Coal Research Laboratory of Kansas State College was used in this portion of the experiment because the hygrothermographic recordings were reasonably constant, the chainometric balance was available, and more working space was guaranteed. Here the temperature and the relative humidity were nearly constant at 86° F. and 12 per cent respectively.

The materials, mixtures of materials and the dilutions used in the following tests were the same as those used in the absorption tests. A small quantity of bran, about 15 grams, was placed in the Buchner funnel and covered with water. After 10 minutes it was drained for two minutes. The suction action caused by the aspirator attachment drained the free water from the bran. The bran was then

dumped out and five samples were obtained from this quantity and weighed. Individual samples were then spread out on the waxed papers, which were placed on a desk top away from any influences of abnormal conditions, such as heat, drafts, and sunshine. At the end of 30, 60, 90, and 240 minute intervals the samples were weighed. This was done by folding the waxed paper around the samples. Then each sample was brought back to its original air-dried condition and weighed. When the above treatment was applied to the carriers, the different attrahent solutions were substituted for the water. The dilutions of the attrahents were the same as those used in the absorption tests.

To determine whether a longer soaking period would permit the carriers to absorb more moisture and to ascertain whether they would retain the moisture longer, bran, pine and kiln-dried sawdusts were allowed to soak for 240 minutes instead of 10. Beet syrup and molasses were tested in a similar manner.

The possible sources of error in the above tests were as follows: The suction of the Buchner funnel might have varied with the water pressure but since no apparent variation was noticed, it was not considered. The molasses and beet syrup had a greater viscosity than did the water. The suction would be lower when comparing the moisture drained

from the two solutions, but would be comparable in the comparison of two carriers treated with molasses or beet syrup.

EXPERIMENTAL DATA

Absorption

Table 2 contains the data secured from the absorption tests. Plate I is a graphic representation of this table, and shows that the carriers vary greatly among themselves and to the different treatments. When soaked in water the corn stalks (Fig. 11), cottonwood sawdust (Fig. 9), and beet pulp (Fig. 13) were the only three carriers with greater imbibition than bran (Fig. 1). This can be seen in comparing the figures. In the first soaking period which was two minutes, the corn stalks absorbed 22.2 gm. more moisture than did the bran, cottonwood sawdust 9.7 gm. more, while the beet pulp absorbed 7.7 gm. less than the bran. The greater imbibition of these carriers was probably due to their characteristics. Corn stalks are made up of mostly pith whose cells are large with thin walls of simple cellulose. Cottonwood sawdust, although a wood also has large cells made up of thin walls. The beet pulp was very dry, which may account for the slow imbibition during the first soaking interval.

Table 2. Total absorption of water or water and attractants by carriers for different periods of exposure.

Materials	Absorption period				in minutes							
	2		10		30		60		240		720	
	grams	%	grams	%	grams	%	grams	%	grams	%	grams	%
Corn stalks	105.8	423.1	118.4	473.7	117.2	468.8	120.9	483.7	121.7	486.6	132.3	529.0
Cottonwood sawdust	93.3	373.2	100.7	402.9	105.0	420.0	106.1	424.4	107.7	431.6	118.3	473.2
Beet pulp	75.9	303.4	96.1	384.5	99.8	399.1	104.6	418.3	107.3	429.4	110.8	443.1
Pine sawdust and molasses	79.3	317.1	81.4	325.6	83.9	335.7	86.3	345.1	85.4	341.8	91.6	366.3
Bran	83.6	334.4	84.7	338.8	86.8	347.2	89.9	359.9	91.8	367.2	88.5	354.0
Walnut sawdust	52.8	211.0	61.2	244.9	64.0	256.0	67.7	270.9	80.9	323.9	83.8	335.3
Oak sawdust	39.9	159.5	45.9	183.4	50.4	201.7	58.9	235.8	82.4	264.8	81.8	327.2
Pine and beet syrup	66.3	265.1	68.9	275.7	70.0	280.1	70.4	281.5	76.8	307.2	78.4	313.5
Kiln dried sawdust	60.7	242.9	65.4	261.5	68.4	273.6	68.6	274.2	75.3	301.4	76.2	304.9
Pine sawdust and shorts	70.1	280.4	72.6	290.6	71.8	286.1	74.6	299.0	72.3	289.1	74.1	296.5
Pine sawdust	64.5	258.0	66.4	265.6	73.7	294.9	68.8	275.0	69.8	279.0	74.1	296.5
Alfalfa stem meal	52.9	211.4	62.0	248.2	65.3	261.2	68.5	274.2	69.9	279.8	73.8	295.6
Pine, shorts and molasses	55.5	222.1	56.1	224.6	57.7	230.9	56.8	227.2	55.8	223.3	55.8	223.3
Corn cobs	33.2	132.9	43.7	174.9	45.9	183.6	48.0	192.2	49.5	198.2	53.1	212.5
Bran and molasses	53.7	214.7	55.6	222.2	53.9	215.8	51.7	206.9	51.8	207.2	46.6	186.5
Bran and beet syrup	47.2	188.9	49.9	199.5	49.3	197.4	50.3	201.4	48.8	195.2	45.5	181.9
Kiln dried, shorts and molasses	46.5	185.9	46.4	185.6	47.2	187.8	46.2	184.8	46.5	185.9	43.2	172.9
Kiln dried and molasses	37.3	149.0	40.0	160.1	39.5	158.0	41.7	166.9	43.5	173.8	41.8	167.2
Kiln dried and beet syrup	36.7	146.8	37.7	150.9	38.8	152.3	41.1	164.2	39.9	159.6	40.2	160.9
Kiln dried and shorts	40.8	163.1	41.1	164.5	42.7	170.9	40.9	163.9	41.1	164.4	40.0	160.0

EXPLANATION OF PLATE I

The total absorption of water or water and attrahents by the carriers for different periods of exposure.*

- Fig. 1. By the bran.
- Fig. 2. By the corn cobs.
- Fig. 3. By the pine sawdust from molasses and water.
- Fig. 4. By the pine sawdust and wheat shorts mixture.
- Fig. 5. By the walnut sawdust.
- Fig. 6. By the kiln-dried sawdust and wheat shorts mixture.
- Fig. 7. By the pine sawdust from beet syrup and water.
- Fig. 8. By the kiln-dried sawdust and wheat shorts mixture from molasses and water.
- Fig. 9. By the cottonwood sawdust.
- Fig. 10. By the pine sawdust.
- Fig. 11. By the corn stalks.
- Fig. 12. By the kiln-dried sawdust from beet syrup and water.
- Fig. 13. By the beet pulp.
- Fig. 14. By the alfalfa stem meal.
- Fig. 15. By the kiln-dried sawdust.
- Fig. 16. By the bran from molasses and water.
- Fig. 17. By the oak sawdust.
- Fig. 18. By the bran from beet syrup and water.
- Fig. 19. By the pine sawdust and wheat shorts mixture from molasses and water.
- Fig. 20. By the kiln-dried sawdust from molasses and water.

*Absorption from water unless noted otherwise.

Plate I

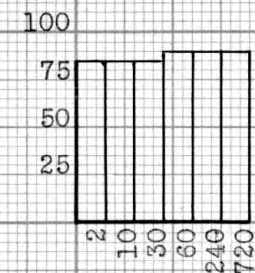


Fig. 1



Fig. 2

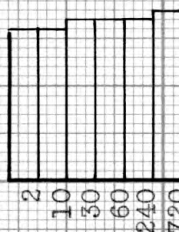


Fig. 3

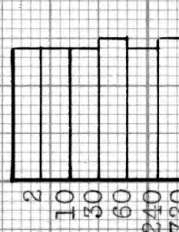


Fig. 4

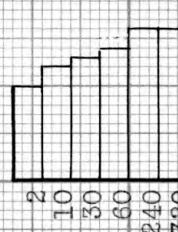


Fig. 5

Minutes Soaked

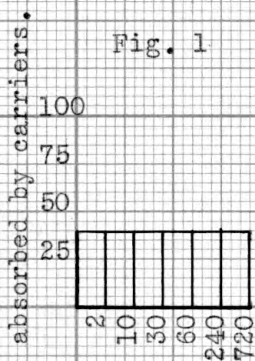


Fig. 6

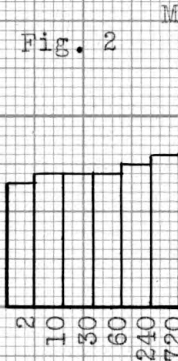


Fig. 7

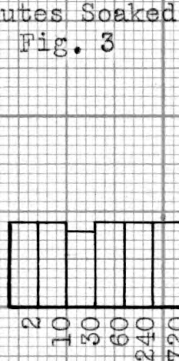


Fig. 8

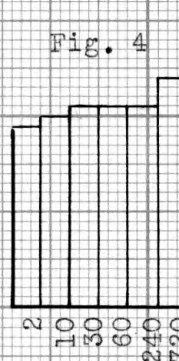


Fig. 9

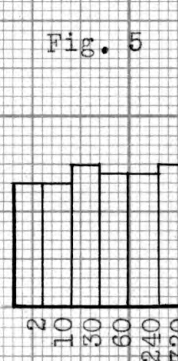


Fig. 10

Minutes Soaked

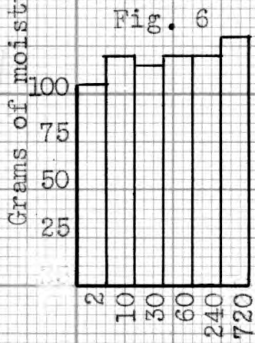


Fig. 11

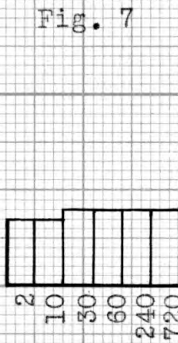


Fig. 12

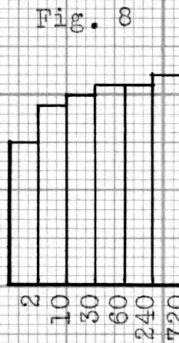


Fig. 13

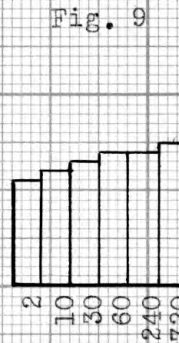


Fig. 14

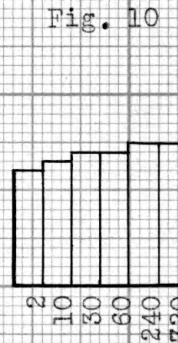


Fig. 15

Minutes Soaked	Weight (g)	Length (mm)	Width (mm)	Volume (mm ³)	Mass (g)	Volume (mm ³)	Density (g/cm ³)
0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15	1.1	1.1	1.1	1.3	1.1	1.3	1.1
30	1.2	1.2	1.2	1.7	1.2	1.7	1.2
45	1.3	1.3	1.3	2.1	1.3	2.1	1.3
60	1.4	1.4	1.4	2.7	1.4	2.7	1.4
75	1.5	1.5	1.5	3.4	1.5	3.4	1.5
90	1.6	1.6	1.6	4.1	1.6	4.1	1.6
105	1.7	1.7	1.7	4.9	1.7	4.9	1.7
120	1.8	1.8	1.8	5.8	1.8	5.8	1.8
135	1.9	1.9	1.9	6.8	1.9	6.8	1.9
150	2.0	2.0	2.0	8.0	2.0	8.0	2.0
165	2.1	2.1	2.1	9.3	2.1	9.3	2.1
180	2.2	2.2	2.2	10.6	2.2	10.6	2.2
195	2.3	2.3	2.3	12.0	2.3	12.0	2.3
210	2.4	2.4	2.4	13.5	2.4	13.5	2.4
225	2.5	2.5	2.5	15.0	2.5	15.0	2.5
240	2.6	2.6	2.6	16.6	2.6	16.6	2.6
255	2.7	2.7	2.7	18.3	2.7	18.3	2.7
270	2.8	2.8	2.8	20.0	2.8	20.0	2.8
285	2.9	2.9	2.9	21.7	2.9	21.7	2.9
300	3.0	3.0	3.0	23.4	3.0	23.4	3.0
315	3.1	3.1	3.1	25.2	3.1	25.2	3.1
330	3.2	3.2	3.2	27.0	3.2	27.0	3.2
345	3.3	3.3	3.3	28.9	3.3	28.9	3.3
360	3.4	3.4	3.4	30.8	3.4	30.8	3.4
375	3.5	3.5	3.5	32.7	3.5	32.7	3.5
390	3.6	3.6	3.6	34.6	3.6	34.6	3.6
405	3.7	3.7	3.7	36.5	3.7	36.5	3.7
420	3.8	3.8	3.8	38.4	3.8	38.4	3.8
435	3.9	3.9	3.9	40.3	3.9	40.3	3.9
450	4.0	4.0	4.0	42.2	4.0	42.2	4.0
465	4.1	4.1	4.1	44.1	4.1	44.1	4.1
480	4.2	4.2	4.2	46.0	4.2	46.0	4.2
495	4.3	4.3	4.3	47.9	4.3	47.9	4.3
510	4.4	4.4	4.4	49.8	4.4	49.8	4.4
525	4.5	4.5	4.5	51.7	4.5	51.7	4.5
540	4.6	4.6	4.6	53.6	4.6	53.6	4.6
555	4.7	4.7	4.7	55.5	4.7	55.5	4.7
570	4.8	4.8	4.8	57.4	4.8	57.4	4.8
585	4.9	4.9	4.9	59.3	4.9	59.3	4.9
600	5.0	5.0	5.0	61.2	5.0	61.2	5.0
615	5.1	5.1	5.1	63.1	5.1	63.1	5.1
630	5.2	5.2	5.2	65.0	5.2	65.0	5.2
645	5.3	5.3	5.3	66.9	5.3	66.9	5.3
660	5.4	5.4	5.4	68.8	5.4	68.8	5.4
675	5.5	5.5	5.5	70.7	5.5	70.7	5.5
690	5.6	5.6	5.6	72.6	5.6	72.6	5.6
705	5.7	5.7	5.7	74.5	5.7	74.5	5.7
720	5.8	5.8	5.8	76.4	5.8	76.4	5.8
735	5.9	5.9	5.9	7			

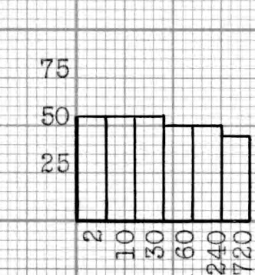


Fig. 16

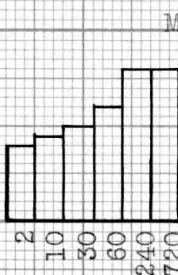


Fig. 17

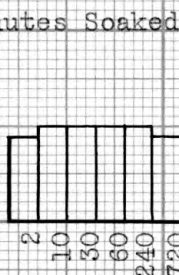


Fig. 18

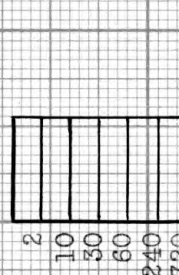


Fig. 19

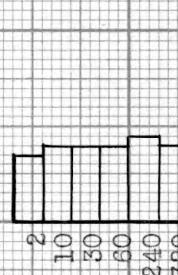


Fig. 20

Minutes Soaked

The remainder of the carriers, walnut sawdust (Fig. 5), oak sawdust (Fig. 17), kiln-dried sawdust (Fig. 15), pine sawdust (Fig. 10), alfalfa stem meal (Fig. 14), and corn cobs (Fig. 2), when soaked for the two minute period absorbed less moisture than the bran. These carriers absorbed, respectively, 30.9, 43.7, 22.9, 19.1, 30.7, and 50.4 less grams of moisture than the bran. From the observations of Miller (10), the lower imbibition of these materials may have been due to the complexity of the celluloses and the size or the presence of large amounts of gums or resins in the cell walls.

Figure 1 shows that the longer period of soaking in water did not greatly increase the amount of moisture absorbed by the bran after the initial soaking of two minutes. As shown in Table 2, bran imbibed only 4.9 gm. more moisture after being soaked for 720 minutes than it did when soaked for two minutes. On the other hand, corn stalks absorbed 26.5 more grams, cottonwood sawdust 25.0, beet pulp 34.9, walnut sawdust 31.0, oak sawdust, 41.9, kiln-dried sawdust 15.5, pine sawdust 9.6, alfalfa stem meal 20.9, and corn cobs absorbed 19.9 more grams after being soaked 720 minutes than for two minutes. Although bran increased the least, it ranked third in the total amount absorbed. This can be seen in Table 3 which shows in grams of moisture

absorbed the carriers as compared to bran. These data were taken from Table 2 which shows the position of the carriers in respect to bran.

Table 3. The grams of moisture absorbed by the carriers as compared to bran.

Materials	Exposure period in minutes					
	2	10	30	60	240	720
Corn stalks	22.2	33.7	30.4	31.0	29.9	43.8
Cottonwood	9.7	16.0	18.2	16.2	15.9	29.8
Beet pulp	-7.7	11.4	13.0	14.7	15.5	22.3
Bran	0.0	0.0	0.0	0.0	0.0	0.0
Walnut	-30.9	-23.5	-22.8	-22.2	-10.9	-4.7
Oak	-43.7	-38.8	-36.4	-31.0	-9.4	-6.7
Kiln dried	-22.9	-19.3	-18.4	-21.3	-16.5	-12.3
Pine	-19.1	-18.3	-13.1	-21.1	-22.0	-14.4
Alfalfa stem meal	-30.7	-22.7	-21.5	-21.4	-21.9	-14.7
Corn cobs	-50.4	-41.0	-40.9	-41.9	-42.3	-35.4

Significant increases in moisture imbibition over that of bran during increased time of soaking was shown by corn stalks, cottonwood sawdust and beet pulp (Table 3). These increases were 43.8, 29.8 and 22.3 gm. of moisture, respectively. Thus, in the preparation of a poison bait with any of these carriers it will be advantageous to allow the carriers to soak over night. The other carriers did not absorb

a significant amount of moisture as compared to bran. They absorbed from 4.7 less grams of moisture for walnut to 35.4 less grams in the case of corn cobs, as may be seen in Table 3.

When wheat shorts were mixed with pine sawdust and soaked in water there was no appreciable difference over the pine sawdust. This difference may be seen in Table 2 and Plate I. The pine sawdust imbibed 64.5 gm. of moisture in the two-minute soaking period and 74.1 gm. after soaking 720 minutes. The wheat shorts and pine sawdust mixture imbibed 70.1 gm. initially and 76.2 gm. after the 720 minute soaking period or an increase of 5.6 and 2.1 gm. of moisture, respectively. The moisture absorbed by the kiln-dried sawdust for the first period was 60.7 gm. and for the 720 minute soaking period was 76.2 gm. When, however, shorts were added to kiln-dried sawdust a significant decrease in imbibition resulted. The shorts and kiln-dried sawdust mixture imbibed only 40.8 gm. for the first period and 40.0 gm. for the 720 minute period or a decrease of 19.9 and 36.2 gm. of moisture, respectively. This may have been due to the blocking action of the shorts or to its lower absorption power. The use of shorts to increase the imbibition of a sawdust bait seems to depend upon physical characteristics of the sawdust.

Bran, and pine and kiln-dried sawdusts were soaked in a molasses solution to compare the differences in the imbibitional power of the carriers as compared with water. The addition of molasses solution to the bran and kiln-dried sawdust lowered the imbibition of the carriers while the reverse was true when the molasses solution was added to the pine sawdust. As seen in Table 2 bran absorbed 83.6 gm. of water and 53.7 gm. of moisture from the molasses solution; the kiln-dried sawdust, 60.7 gm. of water and 37.3 gm. from the molasses solution; while the pine sawdust increased from 64.5 gm. to 79.3 gm. by the addition of the molasses solution. The graphic representations of these treatments for bran may be seen in Figs. 1 and 16, for kiln-dried sawdust in Figs. 15 and 20, and for pine sawdust in Figs. 10 and 3. The decrease in the amount of moisture absorbed by the bran and the kiln-dried sawdust may have been due to the viscosity of the molasses solution or to the non-permeability of the cell walls of the carriers. The cells of the pine sawdust were seemingly permeable since the absorption from the molasses solution was greater than that from the water.

When these same carriers were soaked in a beet syrup solution the imbibitional power was less than when soaked

in either the molasses solution or water. Only the pine sawdust absorbed more moisture from the beet syrup than it did when soaked in water. The bran imbibed 83.0 gm. of moisture from the water, 53.7 gm. from the molasses solution, and 47.2 gm. from the beet syrup solution. The kiln-dried sawdust imbibed 60.7 gm. from the water, 37.3 gm. from the molasses solution and 36.7 gm. from the beet syrup solution while the pine sawdust imbibed 64.5 gm. from the water, 79.3 gm. from the molasses solution and 66.3 gm. from the beet syrup solution. Here again the variation was probably due to the viscosity of the beet syrup solution and its effect on the permeability of the cell walls in the osmotic process.

The mixtures of wheat shorts and carriers when treated with a molasses solution brought different results than did the carriers when treated with molasses solution. The kiln-dried sawdust and shorts mixture when treated with the molasses solution raised the amount of moisture absorbed as compared with the water addition but this was far below the amount absorbed by the kiln-dried sawdust and water. Table 2 shows that the kiln-dried sawdust and shorts absorbed 46.5 gm. from the molasses solution and 40.8 gm. from the water. The mixture of shorts and pine sawdust when treated with the molasses solution showed that the imbibition

decreased as compared to the pine sawdust with water, pine sawdust with shorts added and the pine sawdust with a molasses solution. The pine sawdust and shorts absorbed 55.5 gm. of moisture from the molasses solution, 70.1 gm. from the water while the pine sawdust absorbed 64.5 gm. from the water and 79.3 gm. from the molasses solution. This decrease as compared to the sawdust and molasses solution was probably due to the lower imbibition of the shorts.

Evaporation

The following tests were carried on to determine the moisture retention qualities of the carriers, and the effects that the attractant solutions had on these carriers. All the carriers were soaked for an initial period of 10 minutes. A few were soaked for 240 minutes to observe whether or not there were appreciable differences in the rate of evaporation between the two treatments. After the ten minute soaking period, the carriers subjected to evaporation retained their moisture in proportion to the amount they originally absorbed. This can be seen in Table 4 and Plate II. The data used in these evaporation tests which follow are expressed in grams of moisture per gram of carrier.

The corn stalks (Fig. 26) retained more moisture after 60 minutes of evaporation than the bran (Fig. 24) originally

Table 4. Ability of carriers to retain moisture when subjected to various evaporation intervals.

Materials	Original wt. of water absorbed		Minutes in		evaporation interval**						Average weight of	
			30		60		90		240		sample	
	grams	%	grams	%	grams	%	grams	%	grams	%		
Corn stalks	5.426	500.2	4.349	400.9	3.137	298.2	2.096	193.3	0.141	12.9	1.0848	
Beet pulp	6.259	326.9	5.499	287.2	4.683	244.6	3.815	199.2	0.563	29.4	1.9146	
Alfalfa stem meal	6.248	272.4	5.335	232.6	4.109	179.1	2.879	125.5	0.234	10.2	2.2938	
Bran	5.314	245.9	4.190	193.9	3.114	144.1	2.179	100.8	0.562	22.4	2.1602	
Pine sawdust*	5.652	243.9	4.289	185.1	3.204	138.2	2.282	98.5	0.232	10.0	2.3176	
Pine sawdust	4.691	231.6	3.855	190.4	2.811	138.1	1.934	95.5	0.261	12.9	2.0250	
Bran*	5.598	225.9	4.576	184.7	3.334	134.6	2.515	101.5	0.160	6.5	2.4772	
Cottonwood	4.786	196.8	3.633	149.4	2.455	100.9	1.325	53.5	0.156	6.4	2.4322	
Pine and shorts	5.696	189.8	4.691	156.3	3.763	125.4	3.018	100.6	0.443	14.8	3.0012	
Kiln-dried shorts	5.327	165.9	4.410	137.3	3.265	101.7	2.160	67.3	0.163	5.1	3.2116	
Corn cobs	4.508	158.9	3.545	125.2	2.680	94.5	1.917	67.6	0.207	7.3	2.8360	
Walnut sawdust	3.544	129.4	2.364	86.4	1.266	46.3	0.593	21.6	0.255	8.8	2.7380	
Oak sawdust	4.552	112.8	3.669	90.9	2.785	69.0	2.010	49.8	0.451	11.2	4.0340	
Kiln-dried*	2.802	104.2	1.883	70.1	0.997	37.1	0.198	7.4	0.039	1.5	2.6880	
Kiln-dried	3.759	98.4	2.779	72.8	1.844	48.3	1.113	29.2	0.284	7.4	3.8190	

*Materials soaked in water 240 minutes, others 10 minutes.

**Temperature 86° F. and relative humidity 12 per cent.

EXPLANATION OF PLATE II

Ability of carriers to retain moisture when subjected to various evaporation intervals.*

- Fig. 21. By corn cobs.
- Fig. 22. By beet pulp.
- Fig. 23. By oak sawdust.
- Fig. 24. By bran.
- Fig. 25. By kiln-dried sawdust.
- Fig. 26. By corn stalks.
- Fig. 27. By bran.**
- Fig. 28. By alfalfa stem meal.
- Fig. 29. By pine sawdust and wheat shorts mixture.
- Fig. 30. By pine sawdust.**
- Fig. 31. By pine sawdust.
- Fig. 32. By walnut sawdust.
- Fig. 33. By cottonwood sawdust.
- Fig. 34. By kiln-dried sawdust.**
- Fig. 35. By kiln-dried sawdust and wheat shorts mixture.

*Temperature 86° F. and relative humidity 12 per cent.

**Materials soaked in water for 240 minutes, others 10.

Plate II

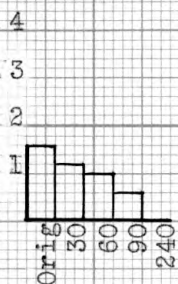


Fig. 21

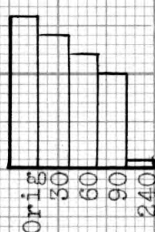


Fig. 22

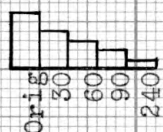


Fig. 23



Fig. 24

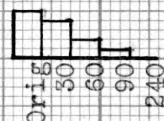


Fig. 25

Grams of moisture per gram of carrier

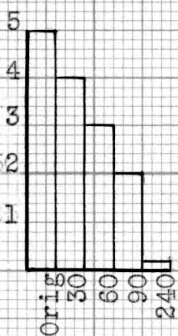


Fig. 26

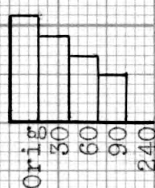


Fig. 27

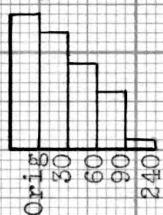


Fig. 28

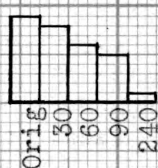


Fig. 29

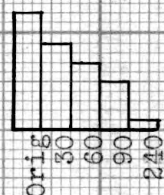


Fig. 30

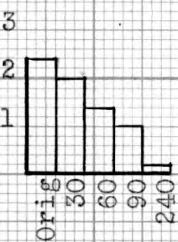


Fig. 31

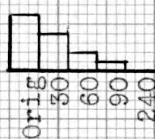


Fig. 32

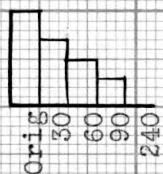


Fig. 33

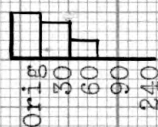


Fig. 34

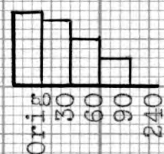


Fig. 35

Minutes Evaporated

absorbed. This amount, 2.98 gm., was nearly the same as the beet pulp, 2.44 gm., when compared with bran, 2.46 gm. These data were compiled from Table 4. Although the alfalfa stem meal (Fig. 28) absorbed 0.27 more grams of moisture originally, it lost its moisture at the same rate as the bran.

The other carriers, pine sawdust (Fig. 31), cottonwood sawdust (Fig. 33), corn cobs (Fig. 21), walnut sawdust (Fig. 32), oak sawdust (Fig. 23), and kiln-dried sawdust (Fig. 25) did not absorb as much moisture as the bran, as can be seen by comparing these figures in Plate II. These carriers lost their moisture upon evaporation proportionally to the amount they originally absorbed. This shows that there is little difference among the carriers' resistance to evaporation.

When comparing the retention properties of pine (Fig. 29) and kiln-dried (Fig. 35) sawdusts mixed with wheat shorts and soaked in water the retention did not vary noticeably from that of bran. This can be seen by the differences in the grams of moisture the carriers retained as compared with bran. The pine sawdust and shorts mixture absorbed 0.57 less grams originally, contained 0.38 less grams after 30 minutes exposure, 0.19 less grams after 60 minutes, retained the same amount after 90 minutes and contained 0.07 less grams than bran after 240 minutes of exposure. The kiln-dried sawdust absorbed 0.80 less grams

originally, contained 0.57 less grams after 30 minutes of exposure, 0.42 less grams after 60 minutes, 0.34 less grams after 90 minutes and 0.17 less grams than bran after the 240 minutes of exposure (Table 4).

When comparing the same property of the mixtures with the carriers the shorts did not alter the rate of evaporation, although it did increase the amount originally absorbed by the kiln-dried sawdust and decreased the amount of moisture absorbed by the pine sawdust. The kiln-dried sawdust shorts mixture increased the amount originally absorbed by 0.68 gm., contained 0.64 more grams of moisture after 30 minutes exposure, 0.54 more grams after 60 minutes, 0.38 more grams after 90 minutes and 0.02 less grams than did the kiln-dried sawdust after 240 minutes of exposure. The pine sawdust and shorts mixture decreased the amount originally absorbed by 0.43 gm., contained 0.34 less grams after 30 minutes exposure, 0.13 less grams after 60 minutes, contained 0.05 more grams after 90 minutes, and 0.02 more grams after 240 minutes exposure than did the pine sawdust. The shorts may or may not increase the absorption power and the only difference between the mixtures and the carriers is that the one which gains the most moisture originally will retain a greater quantity over a longer period of time.

The fluctuation in the above figures in the 90 and 240 minute exposures is too small to be significant.

In an attempt to find whether the carriers would retain the moisture longer if they were soaked for a longer period of time, bran, pine and kiln-dried sawdusts were allowed to soak for 240 minutes. They were then allowed to evaporate for the same intervals of time as when soaked for 10 minutes, and the longer period of soaking did not increase the retention power of the carriers. This is shown by comparing the different carriers with the length of soaking period. The bran originally absorbed 0.2 more grams of moisture after 10 minutes soaking, contained 0.09 more grams after 30 and 60 minutes of exposure, 0.01 less grams after 90 minutes and 0.15 more grams after 240 minutes of exposure than when soaked for 240 minutes. The pine sawdust originally absorbed 0.12 less grams moisture after soaking 10 minutes, contained 0.05 more grams after 30 minutes' exposure, the same amount after 60 minutes, 0.03 less grams after 90 minutes and 0.03 more grams of moisture after 240 minutes of exposure when being soaked 10 minutes than it did after soaking 240 minutes. The kiln-dried sawdust originally absorbed 0.06 less grams of moisture after 10 minutes soaking, contained 0.03 more grams of moisture after 30 minutes exposure, 0.11 more grams after 60 minutes,

0.21 more grams after 90 minutes and 0.05 more grams of moisture after 240 minutes exposure as compared to the 240 minute period of soaking. As shown the variation was not great enough to be significant in these carriers. These data may be seen graphically by comparing Figs. 24 and 27, 30 and 31, and 25 and 34.

The addition of the molasses solution to bran, pine and kiln-dried sawdust did not affect the retention qualities of the materials since the rate of evaporation was similar to what it was when the carriers were soaked in water. The bran originally absorbed 2.46 gm. of water and 1.87 gm. from molasses solution; it contained 1.94 and 1.54 gm. after 30 minutes exposure, 1.44 and 1.34 gm. after 60 minutes, 1.01 and 1.05 gm. after 90 minutes and 0.22 and 0.16 gm. after 240 minutes of exposure, respectively. The pine sawdust originally absorbed 2.32 gm. of water and 1.3 gm. from the molasses solution; it contained 1.9 and 1.0 gm. after 30 minutes of exposure, 1.38 and 0.86 gm. after 60 minutes, 0.96 and 0.6 gm. after 90 minutes, and 0.12 and 0.13 gm. of moisture after 240 minutes of exposure, respectively. By studying Fig. 25, kiln-dried sawdust and water, and Fig. 44, kiln-dried sawdust and molasses solution, the rate of evaporation of these carriers is seen to be readily comparable.

This was also true when these same carriers were treated with the other attrahents, namely beet syrup, glycerine and salt. This may be seen by comparing the amounts of moisture lost by the carriers in the successive exposure periods. Table 5 shows that when treated with a beet syrup solution bran lost 0.33 gm. of moisture during the 30 minute exposure period, pine sawdust lost 0.23 gm., kiln-dried sawdust lost 0.24 gm; in the 60 minute period, bran lost 0.40 gm., pine sawdust 0.31 gm., and kiln-dried sawdust 0.29 gm.; in the 90 minute period, bran lost 0.36 gm., pine sawdust 0.27 gm., and kiln-dried 0.22 gm.; and in the 240 minute period, bran lost 0.75 gm., pine sawdust 0.47 gm., and kiln-dried sawdust 0.33 gm. The differences among the carriers were due to the amounts originally absorbed.

Bran also lost its moisture proportionally from the glycerine and salt solutions as seen in Figs. 45 and 38. Pine and kiln-dried sawdusts did likewise as shown by comparing Figs. 48 and 52 and Figs. 37 and 40. The variation seen here, as before, was due to the amount of moisture originally absorbed by the carriers.

When the molasses solution was added to a mixture of wheat shorts, pine and kiln-dried sawdusts, the same general results were obtained as when the molasses solution was added to the straight carriers. Comparing Fig. 55, pine

EXPLANATION OF PLATE III

The moisture retained by carriers when soaked for ten and 240 minutes* in various attrahent solutions.**

- Fig. 36. By kiln-dried sawdust soaked in beet syrup solution.
- Fig. 37. By kiln-dried sawdust soaked in glycerine solution.
- Fig. 38. By bran soaked in salt solution.
- Fig. 39. By kiln-dried sawdust and wheat shorts mixture soaked in molasses solution.
- Fig. 40. By kiln-dried sawdust soaked in salt solution.
- Fig. 41. By bran soaked in molasses solution.**
- Fig. 42. By kiln-dried sawdust soaked in molasses solution.**
- Fig. 43. By pine sawdust soaked in molasses solution.**
- Fig. 44. By kiln-dried sawdust soaked in molasses solution.
- Fig. 45. By bran soaked in glycerine solution.
- Fig. 46. By pine sawdust soaked in beet syrup solution.
- Fig. 47. By bran soaked in beet syrup solution.
- Fig. 48. By pine sawdust soaked in glycerine solution.
- Fig. 49. By bran soaked in molasses solution.
- Fig. 50. By pine sawdust soaked in molasses solution.
- Fig. 51. By pine sawdust soaked in beet syrup solution.**
- Fig. 52. By pine sawdust soaked in salt solution.
- Fig. 53. By kiln-dried sawdust soaked in beet syrup solution.**
- Fig. 54. By bran soaked in beet syrup solution.**
- Fig. 55. By pine sawdust and wheat shorts mixture soaked in molasses solution.

*Materials soaked in water unless otherwise noted.

**Materials soaked for 240 minutes, others 10 minutes.

Plate III

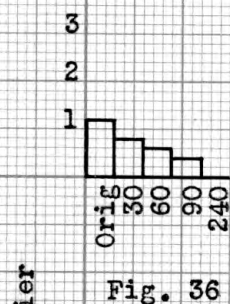


Fig. 36

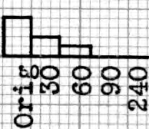


Fig. 37

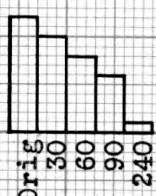


Fig. 38



Fig. 39

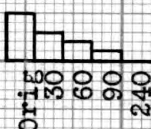


Fig. 40

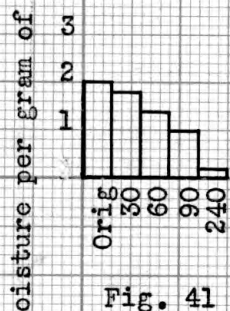


Fig. 41

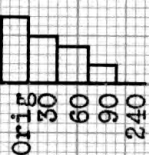


Fig. 42

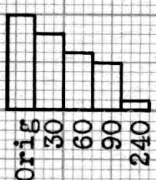


Fig. 43

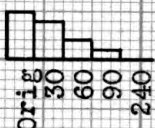


Fig. 44

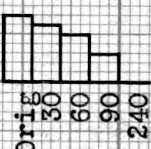


Fig. 45

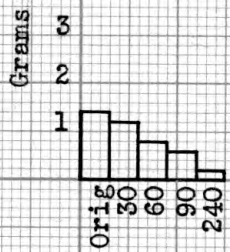


Fig. 46

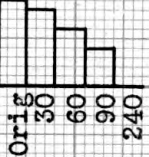


Fig. 47

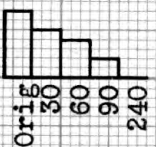


Fig. 48

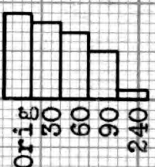


Fig. 49

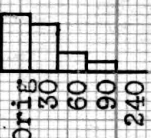


Fig. 50



Fig. 51

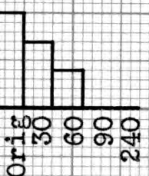


Fig. 52

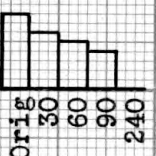


Fig. 53

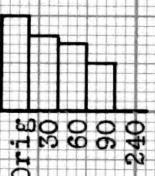


Fig. 54

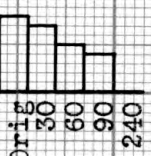


Fig. 55

Table 5. The moisture retained by carriers when soaked for 10 and 240 minutes in various attrahent solutions.

Materials	Original wt. of		Minutes		in evaporation intervals**						Average weight of sample
	moisture absorbed		30		60		90		240		
	grams	%	grams	%	grams	%	grams	%	grams	%	
Bran and salt	5.072	246.5	4.123	200.4	3.338	162.2	2.492	121.1	0.337	16.4	2.0578
Bran and molasses*	5.917	209.3	4.826	170.7	3.724	131.7	2.755	97.4	0.344	12.2	2.8276
Pine and molasses*	5.824	208.9	4.564	163.8	3.574	128.2	2.686	96.4	0.324	11.6	2.7870
Pine and salt	5.777	201.8	3.830	133.8	2.283	79.7	0.801	2.8	0.019	0.7	2.8622
Bran beet syrup*	5.614	192.6	4.859	166.7	3.032	135.5	3.032	104.0	0.271	9.3	2.9146
Bran beet syrup	4.736	189.8	3.918	157.1	2.914	116.8	2.017	80.9	0.153	6.1	2.4948
Bran and molasses	5.227	186.6	4.458	159.1	3.767	134.4	2.968	105.9	0.408	14.6	2.8020
Pine beet syrup*	5.273	158.8	4.303	129.6	3.233	97.4	2.283	68.8	0.388	11.7	3.3200
Kiln-dried beet syrup*	5.112	151.9	4.298	127.4	3.355	99.7	2.464	73.2	0.083	2.5	3.3656
Pine shorts and molasses	4.815	150.5	4.189	130.9	3.302	103.2	2.659	83.1	0.361	11.3	3.1990
Kiln-dried shorts and molasses	5.079	149.6	4.229	124.6	3.481	102.5	2.425	71.4	0.261	7.7	3.3950
Bran glycerine	5.258	148.3	4.353	122.7	3.238	91.3	2.322	65.5	0.328	9.3	3.5468
Pine beet syrup	4.911	139.2	4.112	116.6	3.018	85.5	2.108	59.8	0.446	12.6	3.5280
Pine glycerine	5.037	133.9	3.649	97.0	2.785	74.1	1.633	43.4	0.094	2.5	3.7604
Pine molasses	4.898	129.6	3.080	99.8	1.781	47.1	0.633	16.8	0.064	1.7	3.7790
Kiln-dried beet syrup	4.279	110.9	3.348	86.7	2.223	57.6	1.365	35.4	0.086	2.2	3.8596
Kiln-dried salt	2.669	108.7	1.676	68.2	0.823	33.5	0.277	11.3	0.036	1.5	2.4568
Kiln-dried molasses*	4.490	130.5	3.500	101.8	2.478	72.0	1.505	43.7	0.210	6.1	3.4298
Kiln-dried molasses	4.554	96.3	3.519	76.5	1.986	43.1	0.986	21.1	0.377	8.2	4.6032
Kiln-dried glycerine	2.747	70.5	1.598	40.9	0.818	20.9	0.406	10.4	0.204	5.2	3.8994

*Materials soaked 240 minutes. **Temperature 86° F. and relative humidity 12 per cent.

sawdust, wheat shorts and molasses, with Fig. 50, pine sawdust and molasses, the addition of shorts tended to increase the amount absorbed and to help resist the rate of evaporation up to the 240 minute period. The same results were obtained with kiln-dried sawdust, shorts and molasses (Fig. 39), with kiln-dried sawdust and molasses solution (Fig. 44). The differences in these comparisons were not great enough to be significant as the original amount imbibed was much lower than that absorbed by the bran (Fig. 24).

Bran, pine and kiln-dried sawdusts were then soaked in the attrahent solutions, molasses and beet syrup, for 240 minutes. The results were compared with those obtained from the straight carriers soaked for 10 and 240 minutes in water and with those soaked in the same attrahent solution for 10 minutes. The increase in time (Figs. 24, 27, 41, and 49) did not influence the retention properties of the bran. The same was found true when comparing Figs. 30, 31, 43, and 50 for pine sawdust and Figs. 25, 34, 42, and 44 for kiln-dried sawdust. The amounts of moisture originally absorbed varied but the rate of evaporation was proportional in the three cases.

The resistance of the carriers to evaporation was not significantly affected by the treatments to which they were subjected. Since the environmental conditions greatly

influenced the type of cell structure and characteristics of the plants from which the carriers were obtained, the above results are true of the carriers which were treated. Plants grown in another environment would probably contain different kinds and amounts of cellulose, gums and resins which might change their reactions to the above treatments.

SUMMARY

During the recent grasshopper outbreak the high cost and scarcity of bran brought many substitutes into use. These substitute carriers and attractant solutions gave rise to many conflicting reports upon which was the most efficient. In endeavoring to find information concerning the physical properties of the different carriers, some moisture absorption and retention tests were carried out. The soaking periods in the absorption tests were for 2, 10, 30, 60, 240, and 720 minutes, while in the retention tests, the carriers were soaked for 10 and 240 minutes and then permitted to evaporate for periods of 30, 60, 90, and 240 minutes.

The carriers in the order of greatest moisture absorption of water were corn stalks, cottonwood sawdust, beet pulp, bran, and walnut, oak, kiln-dried and pine sawdusts, alfalfa stem meal and corn cobs. In general, soaking the

carriers for a 720 minute period did not greatly increase their imbibition over the two-minute period. The addition of wheat shorts mixed with pine and kiln-dried sawdusts in a 1/3 ratio decreased the imbibition of the kiln-dried sawdust. The treatments of molasses and beet syrup solutions to bran, and the pine and kiln-dried sawdusts inhibited the amount of moisture absorbed by the bran and kiln-dried sawdust. When wheat shorts were mixed with pine and kiln-dried sawdusts and soaked in a molasses solution the imbibition was lowered in both materials.

From the studies on the resistance of the carriers to evaporation it was found that in all the tests that the moisture was lost in proportion to the amount originally absorbed. This was also true when the carriers were soaked 240 minutes in place of 10. The environmental conditions, the climate, the soil, and the rainfall all influence the growth, the chemical, the physical and the morphological characteristics of the plant materials which are used in part as carriers in baits. Because of this, carriers will vary widely in their reaction to any of the above treatments

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